PEARSON

Physics

Authors

James E. Ackroyd
Westwind School Division
Cardston, Alberta
formerly *J.T. Foster School*
Livingstone Range School Division
Nanton, Alberta

Mark Anderson
Curriculum Leader
Distributed Learning CBe-learn Online School
Calgary Board of Education
Calgary, Alberta

Carmen Berg
formerly *John G. Diefenbaker High School*
Calgary Board of Education
Calgary, Alberta

Dr. Brian E. Martin
Professor of Physics and Astronomy
The King's University College
University of Alberta
Edmonton, Alberta

Barry L. S. McGuire
formerly *Western Canada High School*
Calgary Board of Education
Calgary, Alberta

Cliff Sosnowski
Department Head of Science
Louis St. Laurent Catholic School
Edmonton Catholic Schools
Edmonton, Alberta

Mike Szojka
St. Francis Xavier High School
Edmonton Catholic Schools
Edmonton, Alberta

Elgin Wolfe
Professor
Department of Curriculum, Teaching and Learning
OISE/University of Toronto
Toronto, Ontario

Senior Program Consultant

Lionel Sandner
Saanich School District
Saanichton, British Columbia
formerly *Lead Coordinator,*
Pan Canadian Science Project

Senior Technology Consultant

Josef Martha
Northern Gateway Public Schools
Onoway, Alberta

Program Consultants and Contributors

Igor Nowikow
Markham District High School
York Region District School Board
Markham, Ontario

Paul Williams
Red Deer College
Red Deer, Alberta

PEARSON Education Canada

Copyright © 2007 Pearson Education Canada,
a division of Pearson Canada Inc.

All Rights Reserved. This publication is protected by copyright, and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission, write to the Permissions Department at Pearson Education Canada.

The information and activities presented in this book have been carefully edited and reviewed. However, the publisher shall not be liable for any damages resulting, in whole or in part, from the reader's use of this material.

Brand names that appear in photographs of products in this textbook are intended to provide students with a sense of the real-world applications of science and technology and are in no way intended to endorse specific products.

ISBN-13: 978-0-321-30813-9
ISBN-10: 0-321-30813-1

Printed and bound in the United States

1 2 3 4 5 QC 11 10 09 08 07

About the cover photo
Photo permission by Olivier Grunewald/Oxford Scientific Films/First Light and Courtesy of EISCAT. The photo shows a radar receptor recording wave signals of Northern Lights at Research Base Eiscat, Tromso, Norway. This particular antenna is a 32-m dish, which is the transmitter part of one of EISCAT's three big research radars. Two other antennas similar to this one are in Sweden and Finland.

Managing Editor
Cecilia Chan

Developmental Editors
Nancy Andraos
Lina Mockus
David Peebles
Eileen Pyne-Rudzik, Ph.D.
Yvonne Van Ruskenveld

Coordinating and Production Editors
Anita Reynolds MacArthur
Louise McCauley

Production Editor
Ruth Peckover

Indexer
May Look

Editorial Assistants
Nicole Argyropoulos
Nick Rudzik

Cover and Text Design
ArtPlus Ltd.

Production Coordinators
Suzanne Powell
Sandra Magill

Photo Research
Nancy Belle Cook

Text Composition
ArtPlus Ltd.

Publisher
Reid McAlpine

Product Manager
Patti Henderson

Submission Consultant
Trudy Rising

ACKNOWLEDGEMENTS

The authors and Pearson Education Canada would like to thank Alberta Education for their guidance in the development of this book.

Advisory Panel

Kevin Engel
St. Joseph High School
Edmonton Catholic Schools

David Paraschuk
Bishop O'Byrne High School
Calgary Catholic School Division

Vladimir Pasek
Archbishop O'Leary High School
Edmonton Catholic Schools

Janet Rhine Herrem
St. Martin de Porres High School
Calgary Catholic School Division

Dean Rootsaert
Archbishop Romero High School
Edmonton Catholic Schools

John Watson
Strathcona High School
Edmonton Public Schools

Paul Williams
Red Deer College

Expert Reviewers

Dr. Jason Carey
Assistant Professor
Mechanical Engineering
University of Alberta

Kerry Kijewski
Mathematics and Physics
SAIT Polytechnic

Hans Laue
Formerly *Department of Physics*
University of Calgary

Muraari Vasudevan
Department of Physics
University of Alberta

Sandra Vidaković
Department of Medical Physics
University of Alberta

Ken Vos
Professor
Department of Physics
University of Lethbridge

Dr. Peter Wright
Professor
Department of Educational Psychology
Faculty of Education
University of Alberta

Tony Yeung
Associate Professor
Chemical and Materials Engineering
University of Alberta

Aboriginal Content Consultants

Steven Daniel
Coordinator, Mathematics, Science and Secondary Education
Education, Culture and Employment
Government of the Northwest Territories

Karen Decontie
Structural Engineer
Public Works and Government Services, Calgary

Diane Ingraham, Ph. D.
School of Science and Technology
Cape Breton University

Dawn Wiseman
Creative Director
Mount Pleasant Educational Services Inc., Quebec
(formerly *Native Access to Engineering Program, Concordia University)*

Field-test Teachers

Glen Allen
Harry Collinge High School
Grande Yellowhead Regional Division

Ryan Baldry
Raymond High School
Westwind School Division

Timothy Buttler
Parkview Adventist Academy

Bryan Clintberg
Archbishop O'Leary High School
Edmonton Catholic Schools

Susanne Czentye
Bishop Grandin Senior High
Calgary Catholic School Division

Anthony Green
Austin O'Brien Senior High
Edmonton Catholic Schools

Powell Jones
Ross Sheppard Senior High
Edmonton Public Schools

James Kriese
St. Francis Xavier High School
Edmonton Catholic Schools

Cathy MacAdam
Glenmary School
Holy Family Catholic Regional Division

Craig Noad
Magrath Junior/Senior High School
Westwind School Division

Barry Thimer
Sturgeon Composite High School
Sturgeon School Division

The authors and Pearson Education Canada would also like to thank all the students who participated in the field-test.

Teacher Reviewers

Curtis Blair
St. Albert Catholic High School
Greater St. Albert Catholic Regional Division

Derek Collins
St. Jerome's School
East Central Alberta Catholic Separate Schools

Joan Coy
Peace Academy of Virtual Education
Peace Wapiti School Board

Matt Dyck
J. A. Williams High School
Northern Lights School Division

Don Easton
Formerly *Acadia University*

Michael Enyedy
William E. Hay Composite High School
Clearview School Division

Donald Jamieson
Spruce Grove Composite High School
Parkland School Division

Helen Krol
Edmonton Christian School
Edmonton Public Schools

Wayne Ladner
Chinook Learning Services
Calgary Board of Education

Kari Lagadyn
École Secondaire Ste. Marguerite d'Youville
Greater St. Albert Catholic Regional Division

Karen McMullen
Christ The King School
St. Thomas Aquinas Catholic Schools

Stephen Molesky
École Notre Dame High School
Red Deer Catholic Regional Division

Iain Paton
Didsbury High School
Chinook's Edge School Division

Susan Ruzek
Strathmore High School
Golden Hills School Division

Rachel Sailer
Prairie Christian Academy
Golden Hills School Division

Deana Senn
Grand Centre High School
Northern Lights School Division

Clayton Smiley
E. H. Walter School
Buffalo Trail Public Schools

Duncan Smith
Bishop Grandin High School
Calgary Catholic School Division

Doug Stevens
Foothills Composite High School
Foothills School Division

Robert van Thiel
Father Patrick Mercredi Community High School
Fort McMurray Catholic Board of Education

Natalie Veldhoen
Lord Beaverbrook High School
Calgary Board of Education

Dwayne Wenaas
George McDougall High School
Rocky View School Divisiom

Blaine Woodall
School of Hope
East Central Alberta Catholic Separate Schools

Erin Yeung
formerly *Henry Wise Wood High School*
Calgary Board of Education

UNIT I: KINEMATICS 2

Chapter 1 **Graphs and equations describe motion in one dimension.** **4**
1-1 QuickLab: Match a Motion 5
1.1 The Language of Motion **6**
Minds On: How Do Objects Move? 6
Skills Practice: Finding Position and Displacement 9
1.1 Check and Reflect 10
1.2 Position-time Graphs and Uniform Motion **11**
1-2 Decision-Making Analysis: Traffic Safety Is Everyone's Business 12
1-3 Inquiry Lab: Car Activity 19
1.2 Check and Reflect 20
1.3 Velocity-time Graphs: Uniform and Non-uniform Motion **21**
1-4 QuickLab: Match a Graph 23
Then, Now, and Future: Biomechanics and the Role of the Crash Test Dummy 29
1.3 Check and Reflect 30
1.4 Analyzing Velocity-time Graphs **31**
1-5 Design a Lab: Tortoise or Hare? 33
1.4 Check and Reflect 44
1.5 The Kinematics Equations **46**
1.5 Check and Reflect 53
1.6 Acceleration due to Gravity **54**
1-6 QuickLab: The Bigger They Are... 54
1-7 Inquiry Lab: Determining the Magnitude of the Acceleration due to Gravity 55
1-8 QuickLab: Could You Be a Goalie for the NHL? 57
1.6 Check and Reflect 63
Chapter 1 Summary ***64***
Chapter 1 Review ***65***

Chapter 2 **Vector components describe motion in two dimensions.** **68**
2-1 QuickLab: Taking a One-dimensional Vector Walk 69
2.1 Vector Methods in One Dimension **70**
Skills Practice: Representing a Vector 71
2.1 Check and Reflect 75
2.2 Motion in Two Dimensions **76**
Skills Practice: Directions 78
2-2 QuickLab: Vector Walk 79
Skills Practice: Distance, Displacement, and Position 82
Skills Practice: Using Components 85
2.2 Check and Reflect 90
2.3 Relative Motion **91**
2-3 QuickLab: Table Tennis in the Wind 92
2.3 Check and Reflect 101
2.4 Projectile Motion **102**
2-4 QuickLab: Projectiles 103
2-5 QuickLab: Which Lands First? 104
2.4 Check and Reflect 112
Chapter 2 Summary ***113***
Chapter 2 Review ***114***

Unit I Project **116**
Unit I Summary **117**
Unit I Review **118**

UNIT II: DYNAMICS 122

Chapter 3 **Forces can change velocity.** **124**
3-1 QuickLab: Accelerating a Cart 125
3.1 The Nature of Force **126**
3-2 QuickLab: Measuring Force Using a Spring Scale 128
3.1 Check and Reflect 136
3.2 Newton's First Law **137**
3-3 QuickLab: Challenges with Inertia 138
3-4 Decision-Making Analysis: The Airbag Debate 141
3.2 Check and Reflect 142
3.3 Newton's Second Law **143**
3-5 Inquiry Lab: Relating Acceleration and Net Force 144
3-6 Design a Lab: Relating Acceleration and Mass 147
3.3 Check and Reflect 158
3.4 Newton's Third Law **159**
3-7 QuickLab: Exploding Carts 160
3-8 QuickLab: Skateboard Interactions 163
Then, Now, and Future: Wallace Rupert Turnbull (1870-1954) 166
3-9 Design a Lab: Motion of a Toy Rocket 167
3.4 Check and Reflect 168
3.5 Friction Affects Motion **169**
3-10 QuickLab: Friction Acting on a Loonie 170
3-11 Inquiry Lab: Relating Static Friction and the Normal Force 181
3-12 Design a Lab : Relating Kinetic Friction and the Normal Force 182
3.5 Check and Reflect 190
Chapter 3 Summary ***191***
Chapter 3 Review ***192***

Chapter 4 **Gravity extends throughout the universe.** **194**
4-1 QuickLab: Falling Coins 195
4.1 Gravitational Forces due to Earth **196**
4-2 QuickLab: Relating Mass and Weight 198
4.1 Check and Reflect 202
4.2 Newton's Law of Universal Gravitation **203**
Then, Now, and Future: Small Steps Lead to New Models 214
4.2 Check and Reflect 215
4.3 Relating Gravitational Field Strength to Gravitational Force **216**
4-3 Design a Lab: Comparing Gravitational Field Strength to Gravitational Acceleration 217
4-4 QuickLab: Water in Free Fall 227
4.3 Check and Reflect 229
Chapter 4 Summary ***230***
Chapter 4 Review ***231***

Unit II Project **232**
Unit II Summary **233**
Unit II Review **234**

UNIT III: CIRCULAR MOTION, WORK, AND ENERGY 238

Chapter 5 **Newton's laws can explain circular motion.** **240**

5-1 QuickLab: Characteristics of Circular Motion 241

5.1 Defining Circular Motion **242**

5-2 Inquiry Lab: Speed and Radius 245

5.1 Check and Reflect 247

5.2 Circular Motion and Newton's Laws **248**

Minds On: Spinning Objects in Sports 248

5-3 Inquiry Lab: Speed and Centripetal Force 257

5.2 Check and Reflect 268

5.3 Satellites and Celestial Bodies in Circular Motion **269**

5-4 Design a Lab: Orbital Period and Radius 276

Then, Now, and Future: Extrasolar Planets 283

5-5 Decision-Making Analysis: The Costs and Benefits of Putting a Satellite into Orbit 284

5.3 Check and Reflect 286

Chapter 5 Summary ***287***

Chapter 5 Review ***288***

Chapter 6 **In an isolated system, energy is transferred from one object to another whenever work is done.** **290**

6-1 QuickLab: Energy Changes of a Roller Coaster 291

6.1 Work and Energy **292**

Minds On: Energy of Impact 303

6.1 Check and Reflect 305

6.2 Mechanical Energy **306**

6.2 Check and Reflect 310

6.3 Mechanical Energy in Isolated and Non-isolated Systems **311**

Minds On: Energy and Earth's Orbit 314

6-2 Inquiry Lab: Conservation of Mechanical Energy 317

Minds On: That's the Way the Ball Bounces 320

6-3 Design a Lab: The Energy Involved in a Collision 322

6.3 Check and Reflect 323

6.4 Work and Power **324**

6-4 Inquiry Lab: Measuring the Power Output of a Motor 326

Minds On: Power and Dance 329

Then, Now, and Future: Fuel for the Future? 329

6-5 Problem-Solving Lab: Power and Gears 330

6.4 Check and Reflect 330

Chapter 6 Summary ***331***

Chapter 6 Review ***332***

Unit III Project **334**

Unit III Summary **335**

Unit III Review **336**

UNIT IV: OSCILLATORY MOTION AND MECHANICAL WAVES 340

Chapter 7 **Oscillatory motion requires a set of conditions.** **342**

7-1 QuickLab: Oscillatory Motion of Toys 343

7.1 Period and Frequency **344**

Minds On: Examples of Oscillatory Motion 345

7-2 Inquiry Lab: Relating Period and Frequency 346

7.1 Check and Reflect 347

7.2 Simple Harmonic Motion **348**

7-3 QuickLab: Determining the Stiffness of a Spring 348

7-4 Inquiry Lab: A Pendulum and Simple Harmonic Motion 363

7.2 Check and Reflect 365

7.3 Position, Velocity, Acceleration, and Time Relationships **366**

7.3 Check and Reflect 380

7.4 Applications of Simple Harmonic Motion **381**

7-5 QuickLab: Investigating Mechanical Resonance 384

Then, Now, and Future: Stressed-out Airplanes 386

7.4 Check and Reflect 388

Chapter 7 Summary ***389***

Chapter 7 Review ***390***

Chapter 8 **Mechanical waves transmit energy in a variety of ways.** **392**

8-1 QuickLab: Fundamental Properties of Wave Motion 393

8.1 The Properties of Waves **394**

8-2 Inquiry Lab: Wave Trains in a Ripple Tank, Part 1: Reflecting Waves 396

Minds On: Waves Can Have Curls Too 399

8-3 Inquiry Lab: Wave Trains in a Ripple Tank, Part 2: Wave Speed and Wavelength 399

8.1 Check and Reflect 400

8.2 Transverse and Longitudinal Waves **401**

8-4 Inquiry Lab: Pulses in a Spring, Part 1: Pulses in an Elastic Medium 403

8-5 Inquiry Lab: Pulses in a Spring, Part 2: Speed, Amplitude, and Length 405

Minds On: Wave Motion in Fluids 407

Minds On: Wavelength, Frequency, and Speed 410

8.2 Check and Reflect 410

8.3 Superposition and Interference **411**

8-6 Inquiry Lab: Interference of Waves 414

Minds On: Total Destruction? 416

8-7 Inquiry Lab: Measuring the Speed of Sound Using Closed-pipe Resonance 421

8-8 Design a Lab: Interference Patterns and In-phase Sound Sources 427

8.3 Check and Reflect 428

8.4 The Doppler Effect **429**

Then, Now, and Future: Ultrasound 434

8.4 Check and Reflect 434

Chapter 8 Summary ***435***

Chapter 8 Review ***436***

Unit IV Project **438**

Unit IV Summary **439**

Unit IV Review **440**

UNIT V: MOMENTUM AND IMPULSE 444

Chapter 9 **The momentum of an isolated system of interacting objects is conserved.** **446**

9-1 QuickLab: Predicting Angles After Collisions 447

9.1 Momentum Is Mass Times Velocity **448**

9.1 Check and Reflect 453

9.2 Impulse Is Equivalent to a Change in Momentum **454**

9-2 QuickLab: Softening the Hit 455

9-3 Design a Lab: Providing Impulse 457

9.2 Check and Reflect 467

9.3 Collisions in One Dimension **468**

9-4 QuickLab: Observing Collinear Collisions 469

9-5 Inquiry Lab: Relating Momentum Just Before and Just After a Collision 471

9.3 Check and Reflect 486

9.4 Collisions in Two Dimensions **487**

9-6 Inquiry Lab: Analyzing Collisions in Two Dimensions 488

Then, Now, and Future: Neutrino Research in Canada 498

9.4 Check and Reflect 499

Chapter 9 Summary ***500***

Unit V Project **501**

Unit V Summary **502**

Unit V Review **503**

UNIT VI: FORCES AND FIELDS 508

Chapter 10 **Physics laws can explain the behaviour of electric charges.** **510**

10-1 QuickLab: Charging Objects Using a Van de Graaff Generator 511

10.1 Electrical Interactions **512**

Minds On: Electrical Attraction 512

10-2 Inquiry Lab: Charging Objects 516

10.1 Check and Reflect 523

10.2 Coulomb's Law **524**

10-3 Inquiry Lab: Investigating the Variables in Coulomb's Law 524

Then, Now, and Future: ESD Control Manager 537

10.2 Check and Reflect 538

Chapter 10 Summary ***539***

Chapter 10 Review ***540***

Chapter 11 **Electric field theory describes electrical phenomena.** **542**

11-1 QuickLab: Shielding of Cellular Phones 543

11.1 Forces and Fields **544**

Minds On: Action at a Distance 544

11-2 Inquiry Lab: Observing Electric Fields—Demonstration 546

11.1 Check and Reflect 553

11.2 Electric Field Lines and Electric Potential **554**

Minds On: Drawing Electric Field Lines 555

Then, Now, and Future: Defibrillators Save Lives 559

Minds On: Faraday's Ice Pail 559

11.2 Check and Reflect 569

11.3 Electrical Interactions and the Law of Conservation of Energy **570**

11.3 Check and Reflect 575

Chapter 11 Summary ***577***

Chapter 11 Review ***578***

Chapter 12 **Properties of electric and magnetic fields apply in nature and technology.** **580**
12-1 QuickLab: Magnetic Fields in a Bottle 581
12.1 Magnetic Forces and Fields **582**
12-2 QuickLab: Observing Magnetic Fields 584
Skills Practice: Using the Wire-grasp Rule 588
Then, Now, and Future: Earth's Magnetic Field 591
12.1 Check and Reflect 592
12.2 Moving Charges and Magnetic Fields **593**
Skills Practice: Using the Left-hand Rule for Deflection 595
12-3 Inquiry Lab: Using Hand Rules with a Cathode-ray Tube — Demonstration 595
12.2 Check and Reflect 601
12.3 Current-carrying Conductors and Magnetic Fields **602**
12-4 QuickLab: Demonstration of a Current-carrying Conductor in a Uniform Magnetic Field 606
12-5 Design a Lab: Using the Current Balance to Measure the Magnetic Force Between Two Current-carrying Conducting Wires 608
12-6 Inquiry Lab: Magnetic Fields and Moving Conductors — Demonstration 612
12.3 Check and Reflect 613
12.4 Magnetic Fields, Moving Charges, and New and Old Technologies **614**
12-7 Inquiry Lab: The Curious Relationship Between Motors and Generators 616
Minds On: Perpetual Motion? 617
Minds On: Lenz's Law 618
Then, Now, and Future: Nanotechnology 619
12.4 Check and Reflect 620
Chapter 12 Summary ***621***
Chapter 12 Review ***622***

Unit VI Project **624**
Unit VI Summary **625**
Unit VI Review **626**

UNIT VII: ELECTROMAGNETIC RADIATION 632

Chapter 13 **The wave model can be used to describe the characteristics of electromagnetic radiation. 634**

13-1 QuickLab: Investigating Light as a Form of EMR 635

13.1 What Is Electromagnetic Radiation? 636

Minds On: Going Wireless 645

Then, Now, and Future: From Analog Radio to Digital Wireless 646

13.1 Check and Reflect 647

13.2 The Speed of Electromagnetic Radiation 648

13-2 QuickLab: Measuring the Speed of EMR 651

13.2 Check and Reflect 652

13.3 Reflection 653

13-3 QuickLab: Drawing a Ray Diagram 655

Minds On: Image in a Mirror 655

Minds On: Image Characteristics 656

13-4 QuickLab: Converging and Diverging Mirrors 660

Minds On: Seeing Is Believing—Or Is It? 661

13-5 Problem-Solving Lab: Using a Converging Mirror to Heat Water (Determining the Focal Length of a Converging Mirror) 663

13.3 Check and Reflect 665

13.4 Refraction 666

13-6 Inquiry Lab: Determining the Refractive Index of a Variety of Materials 671

13-7 Decision-Making Analysis: Fibre Optics: Endless Light 674

13-8 QuickLab: Dispersion Using a Prism 677

13-9 Inquiry Lab: Comparing Keplerian and Galilean Telescopes 682

13.4 Check and Reflect 683

13.5 Diffraction and Interference 684

13-10 Inquiry Lab: Determining the Wavelength of Red, Green, and Blue Light 694

Minds On: Comparing Spectra: Dispersion vs. Diffraction 695

13.5 Check and Reflect 697

***Chapter 13 Summary* 698**

***Chapter 13 Review* 699**

Chapter 14 **The wave-particle duality reminds us that sometimes truth really *is* stranger than fiction! 702**
14-1 QuickLab: The Relationship Between Temperature and Colour of an Incandescent Object 703
14.1 The Birth of the Quantum 704
Minds On: What's Wrong with This Analogy? 707
14.1 Check and Reflect 710
14.2 The Photoelectric Effect 711
14-2 QuickLab: Discharging a Zinc Plate Using UV Light 711
Minds On: Light a Particle? Heresy! 713
14-3 Design a Lab: Using the Photoelectric Effect to Measure Planck's Constant 717
14.2 Check and Reflect 720
14.3 The Compton Effect 721
Minds On: Heisenberg's Microscope Problem 722
14.3 Check and Reflect 725
14.4 Matter Waves and the Power of Symmetric Thinking 726
Then, Now, and Future: The Electron Microscope 727
Minds On: Interpret the Graph 729
Minds On: What's Different Now? 731
Minds On: Planck in a Box 733
Minds On: Physics and Certainty 735
14.4 Check and Reflect 736
14.5 Coming to Terms with Wave-particle Duality and the Birth of Quantum Mechanics 737
14-4 QuickLab: The Two-Slit Interference Experiment with Particles 737
14.5 Check and Reflect 740
***Chapter 14 Summary* 741**
***Chapter 14 Review* 742**

Unit VII Project 744
Unit VII Summary 745
Unit VII Review 746

UNIT VIII: ATOMIC PHYSICS 750

Chapter 15 **Electric force and energy quantization determine atomic structure.** **752**

15-1 QuickLab: Cathode Rays and Magnetic Fields 753

15.1 The Discovery of the Electron **754**

Minds On: Evidence for Atoms 754

Minds On: Are Electrons Positively or Negatively Charged? 755

Then, Now, and Future: The Mass Spectrometer 759

15.1 Check and Reflect 760

15.2 Quantization of Charge **761**

15-2 QuickLab: Determining a Fundamental Quantity 761

15.2 Check and Reflect 765

15.3 The Discovery of the Nucleus **766**

15-3 QuickLab: Using Scattering to Measure a Hidden Shape 766

15.3 Check and Reflect 770

15.4 The Bohr Model of the Atom **771**

15-4 Design a Lab: Emission Spectra of Elements 772

15-5 Inquiry Lab: An Emission Spectrum 777

15.4 Check and Reflect 780

15.5 The Quantum Model of the Atom **782**

15.5 Check and Reflect 784

Chapter 15 Summary ***785***

Chapter 15 Review ***786***

Chapter 16 **Nuclear reactions are among the most powerful energy sources in nature.** **788**

16-1 Inquiry Lab: Radiation Intensity 789

16.1 The Nucleus **790**

16.1 Check and Reflect 796

16.2 Radioactive Decay **797**

Then, Now, and Future: Ionization Smoke Detectors 802

16-2 Design a Lab: Radiation Shielding 806

16.2 Check and Reflect 810

16.3 Radioactive Decay Rates **811**

16-3 QuickLab: Simulating Radioactive Decay 811

Then, Now, and Future: Radiotherapy 815

16.3 Check and Reflect 817

16.4 Fission and Fusion **818**

16.4 Check and Reflect 824

Chapter 16 Summary ***825***

Chapter 16 Review ***826***

Chapter 17 **The development of models of the structure of matter is ongoing.** **828**
17-1 QuickLab: Particle Tracking Simulation 829
17.1 Detecting and Measuring Subatomic Particles **830**
17-2 Inquiry Lab: Building a Cloud Chamber 832
17.1 Check and Reflect 835
17.2 Quantum Theory and the Discovery of New Particles **836**
17.2 Check and Reflect 839
17.3 Probing the Structure of Matter **840**
17.3 Check and Reflect 844
17.4 Quarks and the Standard Model **845**
Then, Now, and Future: Small Particles and Big Science 846
17.4 Check and Reflect 849
Chapter 17 Summary ***850***
Chapter 17 Review ***851***

Unit VIII Project **853**
Unit VIII Summary **854**
Unit VIII Review **855**

Appendix: Student References **860**
Glossary **882**
Numerical Answers **891**
Index **899**
Photo Credits and Acknowledgements **905**

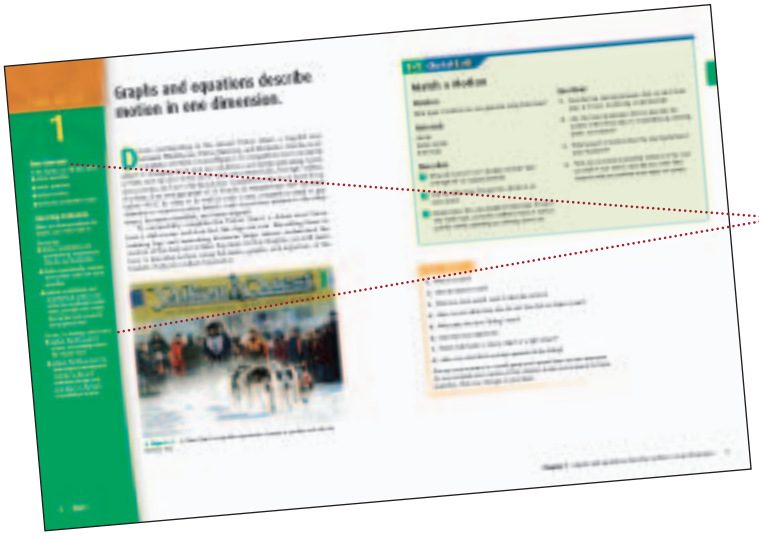
Pearson Physics provides opportunities for you to explore and understand the natural world and to become aware of the profound influence of physics in your lives. It helps you understand the fundamental concepts that explain many physical phenomena and events. With this book, you will learn physics in relevant contexts and engage in activities that bring physics to life.

The book is organized into eight units, corresponding to the eight units in the Alberta Education Physics 20-30 Program of Studies. The material matches the content required in the Program of Studies. Following is an outline of the organization of the text and features.

UNIT OPENER

The pages that begin a **Unit** show a dramatic photograph that is relevant to the unit content. It provides an excellent opportunity for an introductory discussion about the topic of the unit. Also provided on these pages is the **Unit at a Glance**

- ✓ a full table of contents of the unit
- ✓ the general themes of science that are emphasized in the unit
- ✓ the questions to focus on as you study the unit
- ✓ a brief link to the project to be completed at the end of the unit
- ✓ an eWEB link to the *Pearson Physics* website: *www.pearsoned.ca/school/physicssource*



CHAPTER OPENER

Each **chapter** begins with a title in the form of a statement that reflects a General Outcome in the Program of Studies, and an interesting photo relevant to the contents of the chapter.

The **Key Concepts** and **Learning Outcomes** to be addressed in each chapter are listed to provide a clear overview of the material covered in the chapter.

There are always three ways to begin a chapter:

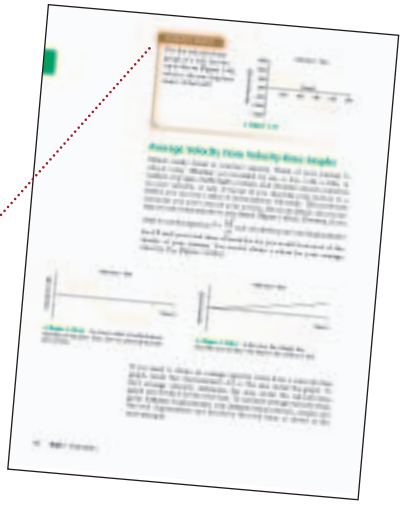
1. The **text narrative** provides the opportunity to develop concept understanding through reading opportunities.
2. **QuickLab** activities provide an opportunity to actively explore initial concepts through short, simple activities.
3. **Think About It** questions provide an opportunity for you to assess what you already know about the chapter's concepts.

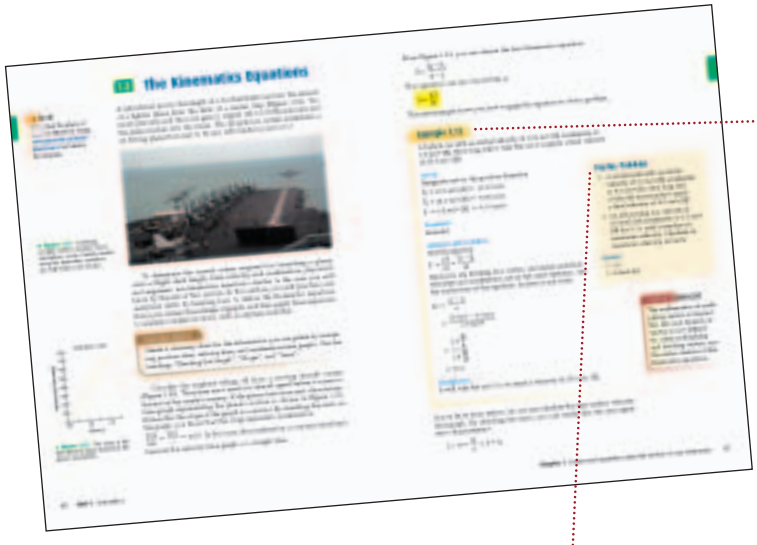
The chapter is further divided into **numbered sections** and **subsections** that organize the contents into appropriate clusters of ideas.

Key terms are shown in bold type in the text. You will also find the definitions of these terms in the margin of the pages. Key equations are highlighted for easy reference.

TEXT FEATURES

Within the body of the text, you will find **Concept Checks** that support and build conceptual understanding and promote the development of inquiry and communication skills.





Problem solving is an essential part of learning physics. You will find numerous **Example Problems** that show detailed step-by-step solutions, generally using the GRASP or GRASP V method. This method is explained in detail in the Student References at the end of the book.

Accompanying each Example Problem are **Practice Problems** reflecting the example problem and providing opportunities for further practice. Answers to Practice Problems are provided on the same page in smaller type. Complete solutions for all questions are provided on the teacher's Solutions Manual Disk.

Skills Practice reviews or reinforces skills that are needed to further understand the mathematical treatment of some of the topics.

Minds On activities are designed to stimulate thinking about key aspects of the concept being studied. It is usually suggested that these activities be done in groups.

Then, Now, and Future are active features that illustrate historical items, interesting current events, and possible future innovations. They are designed to help you better establish connections between the content of the book and the broader world of physics.

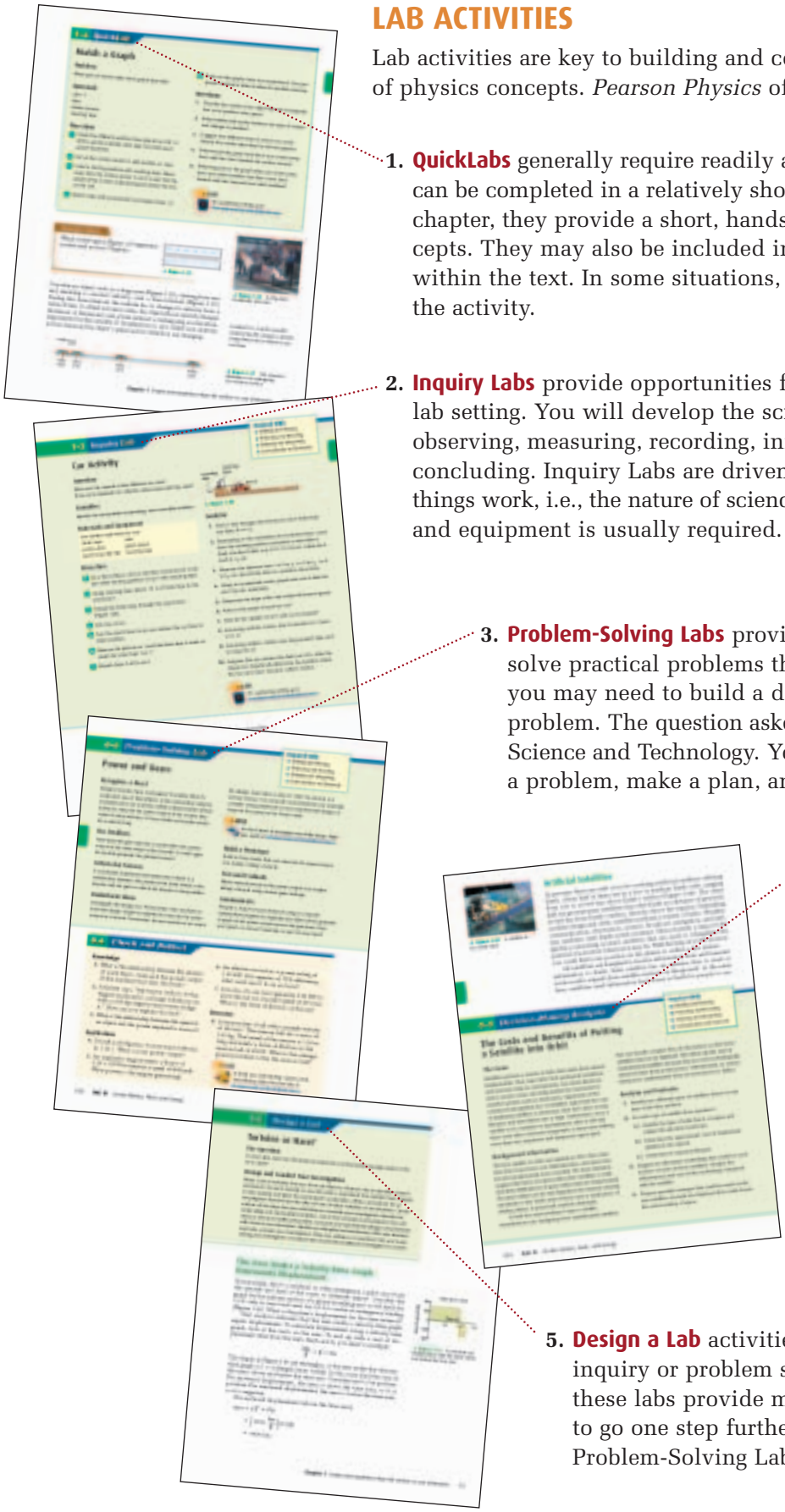
Features found in the margin include **InfoBits** which offer interesting information relevant to the content of the text.

As well, **Physics Insight** features provide additional support for some of the concepts in the flow of the text. They may also provide alternative problem-solving strategies and different mathematical operations that may be helpful for the Example Problems.

Pearson Physics is fully integrated with a high level of technology support. Icons in the margin indicate possible links on the website *www.pearsoned.ca/school/physicssource*. See page xxiii for details of the technology features.

LAB ACTIVITIES

Lab activities are key to building and consolidating real understanding of physics concepts. *Pearson Physics* offers five kinds of lab activities.



1. **QuickLabs** generally require readily available, simple materials and can be completed in a relatively short time. At the beginning of a chapter, they provide a short, hands-on introduction to key concepts. They may also be included in other appropriate places within the text. In some situations, your teacher may demonstrate the activity.

2. **Inquiry Labs** provide opportunities for you to work in a formal lab setting. You will develop the scientific skills of predicting, observing, measuring, recording, inferring, analyzing and, often, concluding. Inquiry Labs are driven by our curiosity about how things work, i.e., the nature of science. Safety is stressed throughout, and equipment is usually required.

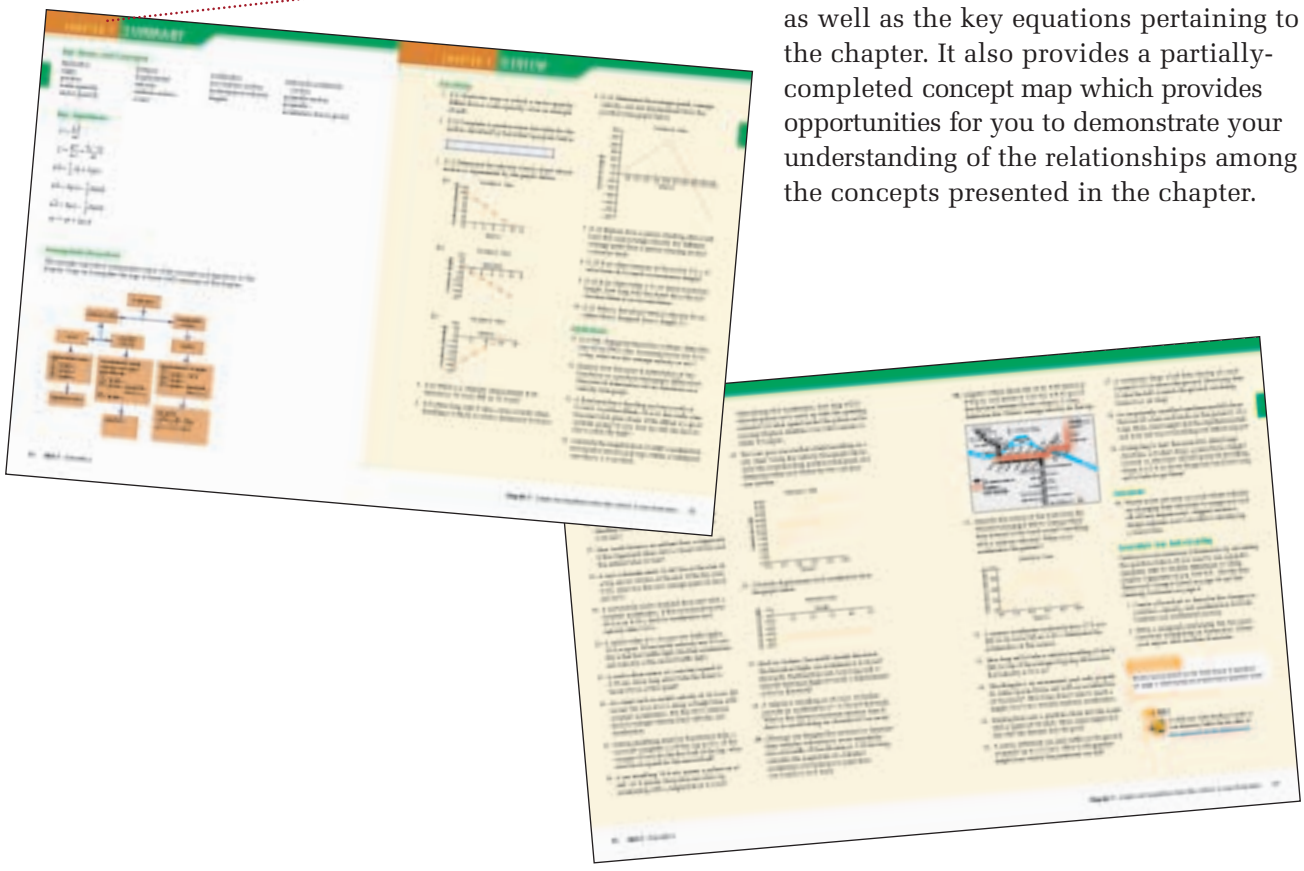
3. **Problem-Solving Labs** provide opportunities for you to solve practical problems that arise from human needs; you may need to build a device or system to solve a problem. The question asked is designed to focus on Science and Technology. You will be asked to identify a problem, make a plan, and construct a solution.

4. **Decision-Making Analysis** activities provide you with activities in which to explore the social, economic, environmental, political, ethical, and moral impacts of a real-world issue related to the unit being studied. You will be asked to work together collecting evidence, and to make a decision based on your research.

5. **Design a Lab** activities can be either scientific inquiry or problem solving in nature. In general, these labs provide minimal direction, asking you to go one step further than either the Inquiry or Problem-Solving Labs by designing the lab yourself.

REVIEW, CONSOLIDATION AND ASSESSMENT

Each numbered section ends in a **Check and Reflect** consisting of numerical and conceptual problems that allow you to review what you have learned and to consolidate your understanding.

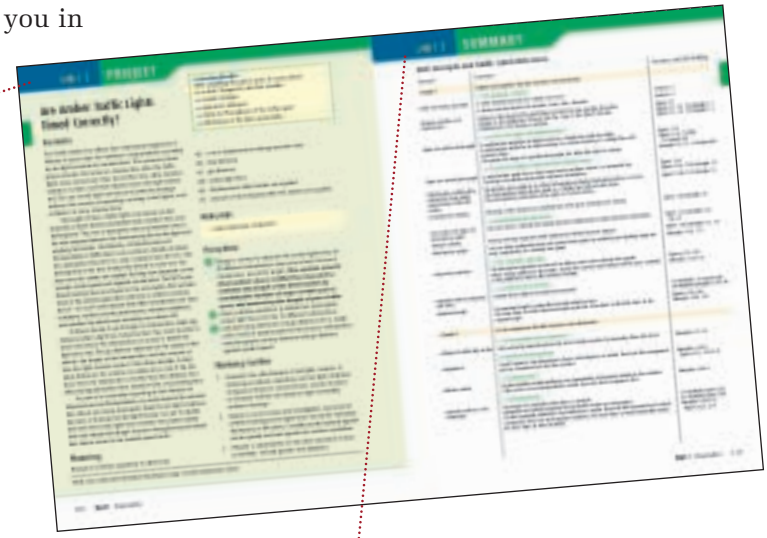


The **Chapter Summary** at the end of each chapter lists the key terms and concepts as well as the key equations pertaining to the chapter. It also provides a partially-completed concept map which provides opportunities for you to demonstrate your understanding of the relationships among the concepts presented in the chapter.

Chapter Review questions at the end of each chapter help you to re-visit the series of concepts covered in a chapter. Answering these questions will help you consolidate what you have learned in the various lessons leading up to this point.

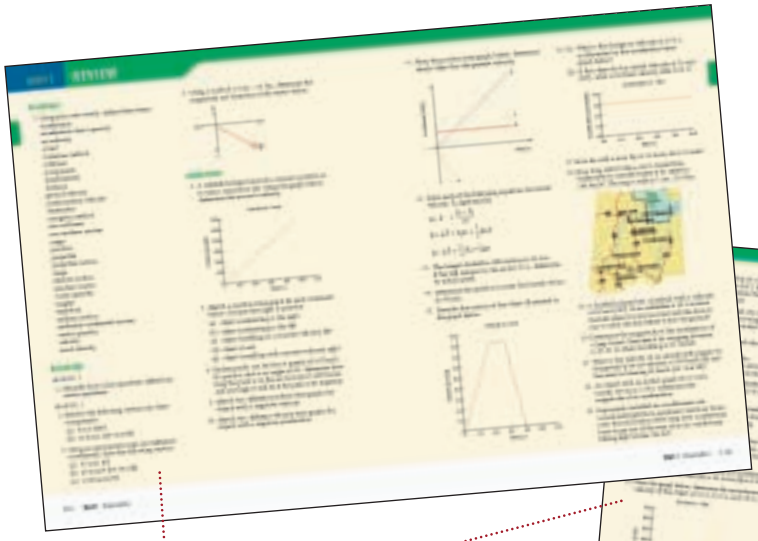
Note: Due to the fact that Unit V has only one chapter, the Chapter Summary for Chapter 9 is immediately followed by the end-of-unit-material described below and a Chapter Review is not included.

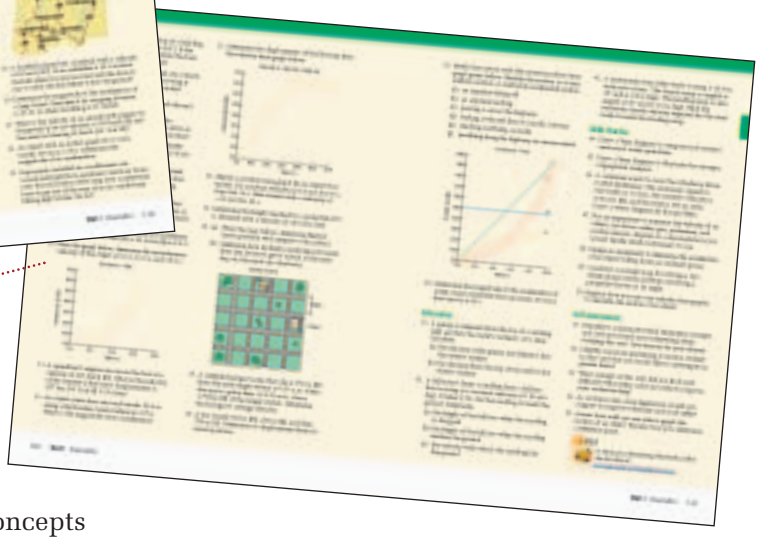
The following features conclude each of the eight units, and are designed to assist you in preparing for major assignments.



The **Unit Project** provides a hands-on opportunity for you to demonstrate what you have learned. The project requires you to integrate and apply some of the skills and knowledge that you have acquired to a new situation.

The **Unit Summary** provides a quick reference for the entire unit. At a glance, you can find all the key concepts you have learned within the unit. This page can help you organize your notes for studying. You may also use it as a checklist to track your understanding as you work through the unit.

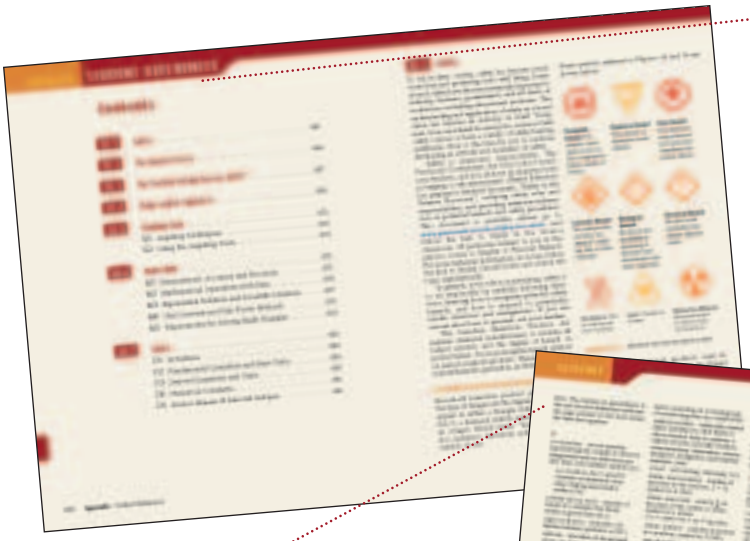




The **Unit Review** provides you with opportunities to:

- ✓ Review important terms (Vocabulary)
- ✓ Test your basic understanding of Key Concepts and Learning Outcomes (Knowledge)
- ✓ Test your ability to combine ideas from more than one section or chapter to answer questions (Applications)
- ✓ Test your ability to apply your learning beyond what you have studied in the unit. (Extensions)
- ✓ Test the specific mathematical skills or laboratory skills you have learned in the unit (Skills Practice)
- ✓ Express your thoughts and ideas about the new things you have learned (Self-Assessment)

END-OF-BOOK RESOURCES



The **Student References** provide you with all the reference material you will need to be successful in the course, including lab safety, scientific and mathematical skills, the GRASP and GRASP V problem solving method, and different kinds of investigative skills.

The **Glossary** includes concise definitions and page references of all key terms introduced throughout the book.

The **Numerical Answers** section allows you to quickly check if you have the correct answers to numerical questions. Complete step-by-step solutions, plus graphical answers and diagrams, are provided on the teacher's Solutions Disk.

The **Index** makes it easy to locate key topics in the book.

TECHNOLOGY INTEGRATION
www.pearsoned.ca/school/physicssource

Pearson Physics is fully integrated with a high level of technology support. Icons throughout the printed Student Edition make references to the website *PhysicsSource* where numerous online resources and support are provided.

While the *Pearson Physics* student book provides complete coverage of the Program of Studies, *PhysicsSource* provides alternative and supplementary treatments of content in a way that may have greater appeal or effectiveness for some students and/or teachers.

Key technology features include:

eLAB provides Probeware labs that can be done in the place of ones in the text that use conventional equipment. There is also a number of additional eLABs with no direct parallels in the book. These are designed to enhance your depth of understanding

eMATH provides spreadsheet applications that may enhance your learning of concepts where mathematical approaches may be particularly complex, or a graph might help.

eSIM provides interactive learning objects. The associated lessons are designed to improve concept understanding and problem solving skills. eSIM objects are a valuable way for you to work independently and to visualize the more complicated concepts in action. They may be used by your teacher for demonstration to the class, for independent student work as part of a lab, or as extensions or remedial work.

eTECH provides opportunities to use Interactive Physics and VideoPoint activities, to further enhance understanding of some of the key concepts.

eTESTs are interactive self-tests at the end of every section, chapter, and unit. The eTESTs cover the same content as the Check and Reflect, Chapter Review, and Unit Review features of the textbook with different questions. Feedback on most questions answered is immediate.

eWEB provides links to potential websites that you can trust as sources of information for further research. Links and topic information are continually updated.